Volume 2, Issue 1 April 2014

Fermilab's Advanced Superconducting Test Accelerator

ASTA Newsletter

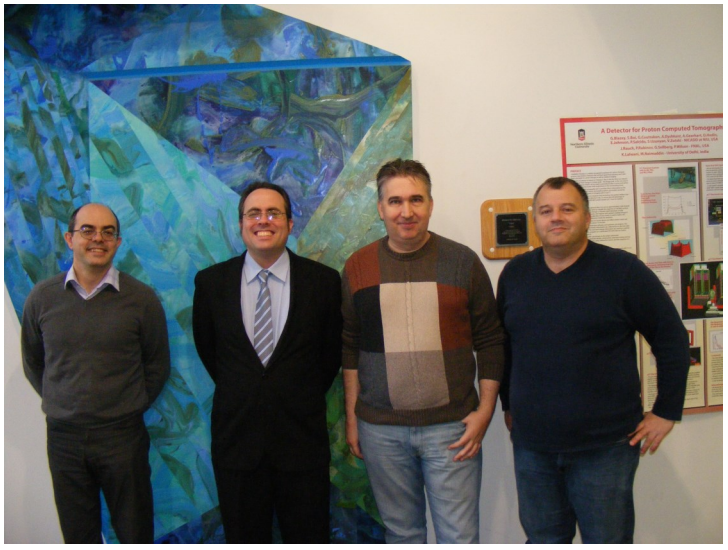
ASTA: Impressive Start in 2014; Users Meeting June 9-10

In 2014 the ASTA team continues impressive progress: we are finishing RF commissioning of the SRF cryomodule and installation of the 50 MeV beamline, high charge electron bunches are extracted from the Ce_2Te photocathode and accelerated to ~5 MeV in the RF gun. We are on track to deliver the first beam to users early this summer (see *pp.2-3*). The **2014 Users Meeting** is set for June 9-10 (see *p.4*). The report of the October 2013 DOE OHEP review of the ASTA facility proposal (October 2013) evaluated ASTA as a unique facility with the greatest "...potential to seed or enhance future capability in support of HEP" and the only one which permits so-important advanced proton beam R&D. Following the Committee recommendations, in March 2014 we have submitted a modified plan for ASTA which is centered at the IOTA ring and its two injectors—the NML electron linac and the proton RFQ previously used by the HINS project in MDB at Fermilab.

Northern Illinois University student Francois Lemery (right) talks with NIU President Douglas Baker (left) and Congressman Randy Hultgren during a visit to ASTA [from *NIU Today* 02/12/2014]

Dr. Chris Prokop — the first PhD based on ASTA-related research !

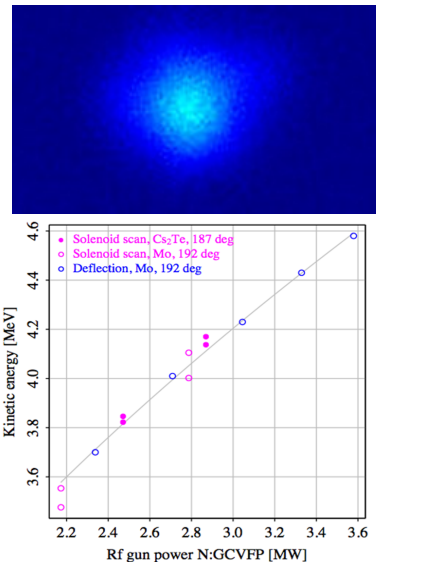
Christopher Prokop of Northern Illinois University successfully defended his PhD dissertation on January 30, 2014. His work included topics related to the design of the ASTA lattice such as the optimization of the high-energy beamline necessary to accommodate first beam and capable of supporting longer-term upgrades, and the design and optimization of ASTA's low-energy bunch compression using a magnetic chicane located in the ~50-MeV photoinjector. Chris also explored beam-physics topics including the development of a chicane-like transverse-to-longitudinal emittance-exchange beamline that could eventually be included downstream of the first cryomodule. Finally, he investigated a single-shot longitudinal-phase-space diagnostics that might be part of future upgrades of the photoinjector. Chris's work was performed in collaboration with Los Alamos National Laboratory's Dr. Bruce Carlsten as part of a lab-directed R&D project to investigate advanced phase-space manipulations for the Matter-Radiation Interactions in Extremes (MaRIE) facility. Some of the studied phase space manipulations will be experimentally studied at ASTA.



Christopher Prokop (2nd from left) with his PhD defense committee : P. Piot (chair), B. Erdelyi, and O. Chmaissem.

High Intensity Beam from ASTA Photoinjector

Since the previous newsletter was published, the ASTA team completed preliminary electron measurements using an uncoated Mo cathode and conditioning the gun to nominal parameters in late February. In the words of Ding Sun, lead scientist for this effort reports, *"… this stage (1 mS, 1Hz) of gun -cavity conditioning is finished: this gun cavity/coupler/window system made by Fermilab team meets the original specification: 40 MV/m, 1ms, 1Hz and can be operated up to 45MV/m."* When a Cs_2Te coated cathode was installed, the gun again needed to be conditioned and this was completed in a matter of days. It is now possible to stably run it at a peak conditions with good vacuum and field emission levels at a peak power of 3.59 MW as measured at the gun with a 1 millisecond long pulse and a 1 Hz repetition rate. This power exceeds that needed to provide the 45 MV/m (3.46 MW) for operation. With the coated cathode installed and gun conditioning completed, ASTA was ready to produce its first electrons from a coated cathode and this was achieved the morning of March 18. The maximum charge being produced now is of the order of three nano-Coulomb per bunch, in line with design. Work is in progress to characterize the beam energy and emittance. Giulio Stancari from Fermilab's Accelerator Physics Center has been participating in beam studies at ASTA and recently provided results of several beam energy scans using both cathodes and two independent means of scanning the energy – deflection and solenoid scans.



(Top) YAG screen image of first electrons from a Cs2Te cathode and (bottom) electron energy vs. RF gun power at ASTA.

ASTA program is part of Fermilab Agenda for FY2014—FY2019: the document states *"…Accelerator research collaboration using ASTA/IOTA is established and program launched 2016"*

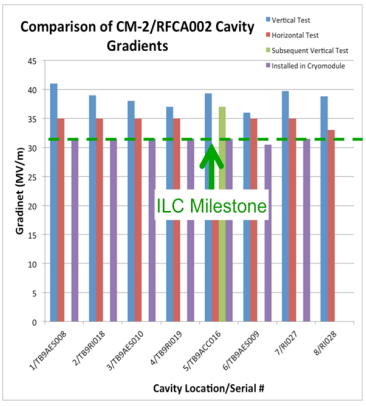
(see Fermilab Today column by FNAL COO V.White *04/08/2014*)

IOTA Quadrupoles Arrive from JINR/Dubna

Last month, 32 high-quality quadrupole magnets arrived at ASTA as an in-kind contribution from Joint Institute of Nuclear Research in Dubna, Russia. The magnets were previously used in the AmPS ring at Amsterdam in the 1990s and feature large aperture and high precision of the magnetic field configuration, which makes them a perfect fit for the IOTA ring requirements. The magnets are in very good shape and will only require a small amount of reconditioning work.

IOTA quadrupole magnets from JINR

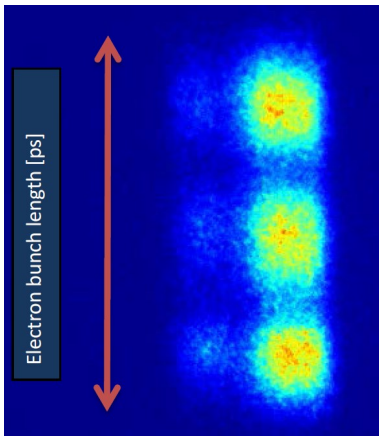
SRF Cryomodule Commissioning Success



The RFCA002, popularly know as Cryomodule 2 (or simply CM-2) is well on the way to becoming a fully operational cryomodule. Installed immediately downstream of the ASTA injector, CM-2 is an 8-cavity Tesla style cryomodule and is the first such device to be assembled at Fermilab. While the cavities were fabricated in industry, all vertical and horizontal tests were conducted at Fermilab. Since mid-November 2013 CM-2 has been cooled to 2K as each of its 8 cavities are powered and characterized one at a time. To date 7 of its 8 cavities have been tested. 6 of them have achieved the administrative gradient limit of 31.5 MV/m, while one cavity reached 30.5 MV/m before spontaneously quenching. Ancillary systems such as the slow tuners, High and Low Level RF, Lorentz Force Detuning Compensation, and thermometry are functioning nearly flawlessly. Typical operating parameters are 1.6 ms pulse width and a repetition rate of 5 Hz. In addition to determining the peak gradient, each cavity's production of x-rays and dark current vs. gradient is recorded and a series of Dynamic Heat Load measurements are made in order to estimate the Q_0. Once the eighth cavity is tested, the waveguide distribution system, which permits all cavities to be powered simultaneously by a single klystron, will be installed and then full cryomodule testing will begin. Early summer should bring with it indications of how well CM-2 performs as a complete cryomodule.

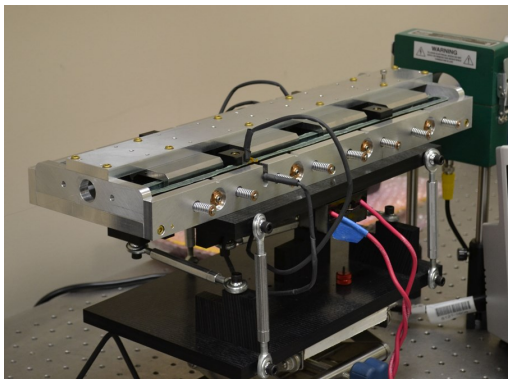
URA funds UMD's ASTA proposal

A research proposal to investigate controlled density perturbations on a high-brightness electron beam at the ASTA has been selected for funding by University Research Association (URA). The proposed work by the University of Maryland scientist Dr. Brian Beaudoin in collaboration with Dr. Jayakar 'Charles' Thangaraj of Fermilab will involve experimentally investigating how density modulations introduced at the beginning of the accelerator evolve in a linear accelerator. The University of Maryland Electron Ring (UMER) research group has long pioneered the ability of generating controlled perturbations to induce space-charge waves using lasers on coasting beams. The proposed experiment will extend such investigations into the regime of acceleration under various beam and machine parameters. ASTA is an ideal venue to conduct this experiment. as it is equipped with state-of-the art laser systems, beam diagnostics and ultra-stable electron beams, enabling a class of beam-based experiments. The generation of longitudinally uniform laser pulses utilizing UV birefringent crystals and temporal pulse stacking, enabled this joint collaboration with Maryland. The UMER-ASTA collaboration looks forward to taking this to the next level utilizing the MHz-class superconducting linac at picosecond pulse scales.



Longitudinal picosecond density modulations along the electron bunch using a streak camera.

IOTA Nonlinear Magnets Development



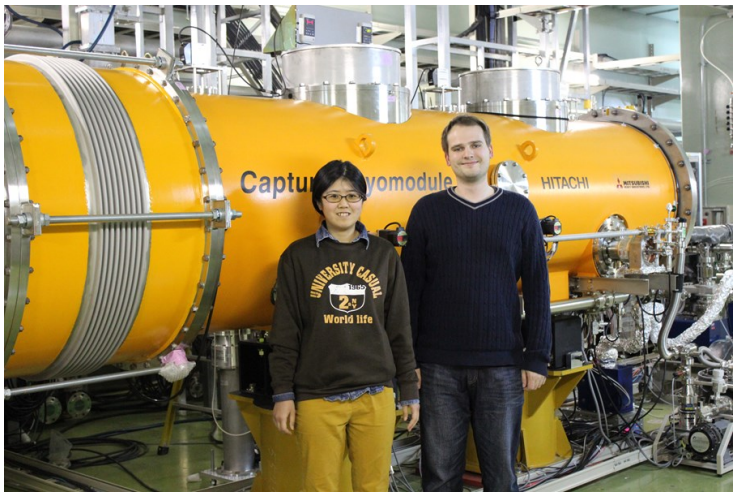
IOTA nonlinear magnet prototype at pulsed wire test stand. Photo courtesy of Radiabeam Technologies, Inc

Special nonlinear magnets are an essential element of the Integrable Optics (IO) experiment at IOTA. A very high magnetic field precision and alignment tolerances are required, making the design quite challenging. The design effort was undertaken by RadiaBeam Technologies, LLC, supported by DOE SBIR grant. In the Phase I of this project RadiaBeam Technologies has performed a 3D design, built and measured a 40-cm long prototype section of the novel IO magnet. In the Phase II, the full scale 2-m IO section will be engineered, fabricated, measured, and then installed and aligned at the IOTA. RadiaBeam will also design the complete vacuum system and the necessary diagnostics for successful beam transport through the insert.

This project involves a close collaboration of RadiaBeam with Fermilab's ASTA scientists.

KEK Students at ASTA

For three weeks in March two PhD students from KEK were at ASTA to participate in studies. Ayaka Kuramoto, who works with Professor Hitoshi Hayano at KEK, conducted HOM characterization studies on ASTA's nine SRF cavities. She has been measuring the HOM spectra for operating TESLA style 9-cell cavities and comparing them with measurements made at DESY and KEK. Mathieu Omet, who is supervised by Shinichiro Michizono, made extensive measurements of the klystron driving the eight-cavity cryomodule (CM2) and developed an algorithm in firmware to cancel the klystron nonlinearities in both amplitude and phase.



Ayaka Kuramoto and Mathieu Omet, PhD students from KEK, spent 3 weeks at ASTA as visiting researchers.

Advanced Superconducting Test Accelerator

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The Advanced Superconducting Test Accelerator (ASTA) currently under construction and commissioning at Fermilab, will enable a broad range of beam-based experiments to study fundamental limitations to beam intensity and to develop transformative approaches to particle-beam generation, acceleration and manipulation. Centerpiece of ASTA is the Integrable Optics Test Accelerator (IOTA) - a small-circumference ring capable of storing electrons or protons—and its electron and proton injector accelerators. ASTA is a unique resource for R&D towards Intensity and Energy Frontier facilities. It also offers a test-bed for SRF accelerators and high-brightness beam applications.

Questions, inquiries? Please visit our Web site http://asta.fnal.gov or contact Dr. Vladimir D. Shiltsev—ASTA Director (Interim) at shiltsev@fnal.gov

Alex Valishev to lead IOTA program

Alexander (Sasha) Valishev of Fermilab's APC too the lead over the ASTA's IOTA program in February 2014. Previous leader of the program, Sergei Nagaitsev has taken on the responsibilities of the Fermilab's Accelerator Division Head. Sergei will remain intellectually and scientifically involved in the IOTA. He will continue to supervise a PhD student from University of Chicago who is doing research on the integrable optics at ASTA. Alex and Sergei had several joint publications on the subject at recent PAC and IPAC conferences.

Alexander Valishev

Sergei Nagaitsev

We are on the Web !
asta.fnal.gov

2nd ASTA Users Meeting: June 9-10, 2014 , Fermilab

The 2nd ASTA User Meeting will be held at Fermilab on June 9-10, 2014, prior to the 47th Annual Fermilab Users Meeting (scheduled June 11-12, 2014).Preliminary agenda, link to the registration page, accommodation options and other information are available at **http://asta.fnal.gov**

The purpose of this meeting is to introduce the ASTA facility, its status and plans, and provide a forum to discuss experiments in the near (~2 year) future and beyond. Parties interested in discussing possible experiments in the areas of accelerator R&D for particle physics at the Intensity and Energy Frontiers, stewardship and applications, including novel radiation sources and SRF accelerators - should contact Philippe Piot (piot@fnal.gov).

The ASTA Users Meeting Organizing Committee includes V.Shiltsev (ASTA Director, Interim), P.Piot (ASTA User Coordinator), A.Valishev (ASTA-IOTA Coordinator) and M.Bruce (Meeting Coordinator).

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